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September 2001

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Detection of Outgassing Species from the Electrical Insulators Using Cyranose E-Nose

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The Cyranose™ electronic nose has been developed utilizing conductive polymer (CP) composite materials to recognize a variety of chemical vapors or classes of vapors by creating a fingerprint of each vapor. The principle of detecting chemical vapors is not new. However, its use for incipient fire detection or detection of gaseous species as a result of the onset of fire, due to heat generated as a result of high current flow in an electrical wire, is novel. What is being assessed and evaluated is the reliability of commercial-off-the-shelf (COTS) electronic noses and their respective advanced electronic packages in various environments. The goal of this work is to infuse these technologies into NASA projects and missions to assure the safety of personnel aboard the International Space Station (ISS). It can also be utilized to monitor air-quality in the cabins of the space shuttle, as a part of the Integrated Vehicle Health Management (IVHM) project and other related NASA projects. In addition, this E-nose technology can be used to assess the quality and reliability of high power electronic package modules with respect to fire event detection or organic contaminant detection. The initial goal was to assess the reliability of COTS E-noses for use in future space applications. While engaged in this effort, findings showed its ability to detect out gassed contaminants that are generated in high power electronic packages due to overheating of electrical interconnects or wires.

View the complete article in PDF.

Motorola MMA1201P MEMS Accelerometer Preliminary Test Report

Ashok K. Sharma
NASA/Goddard Space Flight Center
and
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Motorola MMA1201P is a single-axis, surface micromachined MEMS accelerometer rated for ± 40 G and is packed in a plastic 16-lead DIP package. The operating temperature range is –40 ° C to +85 ° C with a storage temperature range of –40 ° C to +105 ° C. The part can sustain accelerations up to 2000 g from any axis, while unpowered and powered accelerations up to 500 g. The main components of the MMA1201P consist of a surface micromachined capacitive sensing cell (g-cell) and a CMOS signal conditioning ASIC. The g-cell's mechanical structure consists of three consecutive semiconductor plates, defining sensitivity along the Z-axis (orthogonal to flat plane of the chip). A fourth semiconductor plate located in the g-cell allows testing of the accelerometer mechanics and electronics.

A total of 70 of these Motorola MEMS accelerometers were subjected to Incoming Inspection. The Incoming Inspection consisted of visual examination, serialization, X-ray, Thermal Cycling within Low Range -40 to +105 ° C (25 samples) and Thermal Cycling Extended Range -65 to +155 ° C (25 samples). Electrical tests were performed after 100, 200, 500, and 1000 cumulative cycles. Twenty parts were subjected to Mechanical Shocks (MS) of 2000 g with electrical tests after 30, 130, 430, 1430, 2500, 5000, 10000 cumulative shocks.

Preliminary test results show no failures during low TC range testing till 100 cycles and 4% parts failing post 300 – 1000 TC electrical tests. During extended range TC testing, 8 % parts failed post 30 TC electricals and 96% parts failed post 300 electricals. Mechanical shock testing showed no failures till 16 MS and 16 – 20% failures from 130 – 10,000 MS.

The failures are being analyzed. View the complete Motorola MMA1201P MEMS Accelerometers Test Plan and the Preliminary Test Report.

Reverse Currents in Surface Mounted Solid Tantalum Capacitors

Alexander Teverovsky, Ph.D.
QSS Group, Inc.

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Forward and reverse bias polarization and depolarization currents in surface mounted tantalum capacitors have been analyzed. The forward bias currents could be represented as a sum of the absorption currents. Characteristically, absorption currents decline with time after applying voltage according to the power law, $I \sim t^n$, n = 0.75 - 0.9. Additionally, conductivity currents sharply increase with applied voltage according to the Pool-Frenkel mechanism of conductivity and have an activation energy in the range from 0.5 eV to 0.75 eV. The absorption currents are due to electron hopping mechanism and are dominant in tantalum capacitors at relatively low voltages (below 20V) and temperatures (below 75° C). The estimated trap density in tantalum pentoxide layers is approximately 10^{18} cm^{-3} and is similar for all types of capacitors.

A time evolution of reverse currents at voltages below 50% of rated voltage features three periods. First is a relatively short, below 1000 seconds period when the currents are decreasing with time. Then the currents gradually increase 2 to 3 orders of magnitude during several hours. During the third period, which can last hundreds and thousand of hours, the currents stabilize or might have a decreasing trend erratically varying around a quasi-stabilization level. The duration of these three periods varies depending on the applied voltage, temperature, and type of capacitors.

In spite of a significant increase in reverse currents during the second period, their forward characteristics remained virtually unchanged, indicating that at this stage the degradation in tantalum capacitors is fully reversible. Processes of irreversible degradation most likely start during the third, quasi-stabilization period and result in a weakening of the electrical strength of tantalum pentoxide layers and in increasing of the effective resistance of manganese dioxide layers.

Reverse bias stress testing was performed on three types of capacitors (22uF/20V, 6.8uF/35V, and 4.7uF/50V) at room temperature and voltages of 25% and 50% of the rated voltage. Most of the 35V and 50V capacitors failed within several minutes during the 50% testing and within 200 – 300 hours during 25% testing. The 20V capacitors withstood more then 300 hours of the 50% testing and more than 2400 hours of the 25% testing without hard failures.

A mechanism of degradation in reverse biased tantalum capacitors is discussed. The details of the test results and analysis will be published in the forthcoming EEE Links and posted on the NEPP web site.

Preliminary Test Results for DC-DC Converters Noise and Transient Turn-On Characteristics for NASA Applications

Ashok K. Sharma
NASA/Goddard Space Flight Center
and
Alexander Teverovsky, Ph.D.
QSS Group, Inc.

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The reliability of DC-DC Converters has long been a major concern for NASA parts and application engineers. Currently available DC-DC Converters are complex hybrid devices that use a variety of active and passive elements such as power MOSFETs, output diodes, pulse width modulators, ASICs, stacked chip capacitors, optocouplers, inductors/transformers, etc. These DC-DC Converters are specified for various input/output voltages, efficiencies, and power ratings ranging from a few watts to over a hundred watts. The applications of these parts require operation at elevated temperatures and pulse stress conditions. Therefore, the quality and or performance of the elements used in the construction and assembly is crucial. The general failure modes of DC-DC converters experienced over the years, have been due to contamination, poor construction and assembly related defects, Schottky diode failures, optocouplers degradation, stacked chip capacitors failures, and so on. A new failure mode of DC-DC Converters has been observed in a thermal vacuum chamber, which manifested itself as an intermittent output interruption, related to the level of vacuum and temperature. Failure analysis showed that these interruptions were due to the lid deformation caused by the difference in the internal pressure of the hybrid and external pressure created in the chamber. Deformation of the lid was transferred to the solder joints through adhesive coupling of the lid with internal elements of the hybrid. During the thermal vacuum cycling, these deformations resulted in a low cycling creep failure of the solder joints and caused interruptions of the devices' output voltage.

Two other important issues related to the reliability of DC-DC converters are noise and turn-on transients, which are design specific and can be a serious concern in some applications. Switching power in DC-DC converters is a natural source of noise, which is an inherent feature of all pulse-width modulated designs. Under certain conditions, the turn-on transients can create significant voltage spikes at the output of DC-DC converters, which can potentially damage interconnected microcircuits. The goal of this study was to perform preliminary testing of noise and transient turn-on characteristics of a few DC-DC converter part types from suppliers such as VPT, Interpoint, and Lambda Advanced Analog.

The test results showed that at low load conditions and at switching frequencies above 0.2 Hz, the VPT DVHF and DVSA converters generated transients with amplitude above 7V and duration of tens or hundreds of milliseconds. Similar transients can be potentially damaging to certain types of microcircuits rated at 5 V. The low-frequency noise of different DC-DC converters varied by more than 12 orders of magnitude in amplitude. The noise power density can reach more than 0.025 Vpk2/Hz, creating significant interference with operation of sensitive microcircuits. The noise spectrum has resonant frequencies below 100 kHz, which are specific to each type of converters. Interpoint DC-DC converters had the highest level of noise at frequencies below 2 Hz. Both, the noise power density and the characteristic frequencies of noise spectrum depended on the values of input voltages and resistive loads.

The details of this DC-DC Converters noise and transient characterization testing and test results will be posted on the NEPP web site at a later date.

2001 IEEE International Nuclear and Space Radiation Effects Conference Recap

Teresa Farris
NSREC Vice-Chairperson of Publicity

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The 2001 IEEE International Nuclear and Space Radiation Effects Conference was held July 16-20 in Vancouver, B.C., Canada at the Westin Bayshore Hotel. The Conference featured a technical program consisting of 94 oral and poster contributed papers and a Radiation Hardened Workshop featuring 28 posters describing the latest observations in radiation effects. A Short Course on radiation effects offered on July 16 was well received. The Industrial Exhibit featured 33 exhibits.

Supporters include the Defense Threat Reduction Agency, Sandia National Laboratories, Air Force Research Laboratory, Jet Propulsion Laboratory, and NASA-Goddard.

Chairman Marty Shaneyfelt of Sandia National Laboratories welcomed a total of 539 attendees. The 91 international attendees were from various foreign countries.

Key NASA-Goddard committee members were Janet Barth, Technical Chairperson, and Mike Xapsos, Guest Editor. Ms. Barth was responsible for organizing the 9 sessions, along with the poster and workshop sessions. She worked closely with her session chairs to accept the best-qualified papers. The three invited speakers she arranged were very well received. Mr. Xapsos, as Guest Editor, is responsible for assembling the NSREC transactions after the conference. All papers are submitted by the author, reviewed and accepted or rejected for publication.

NSREC, held for the first time outside the U.S., garnered very favorable comments from attendees and exhibitors. NSREC 2002 will be held July 15-19 in Phoenix, Arizona. Visit the web site for more information at http://www.nsrec.com.

Articles Are Being Accepted For The "October 2001" Issue Of

THE NEPP NEWS FLASH

(Deadline for Articles September 28, 2001)

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We want to hear from you! The NEPP News Flash is a monthly publication that allows you to give a brief summary of your latest projects. Articles can be informal and from **one to three paragraphs in length.** If the article is longer, we can always summarize it and then link the summary to the full publication on the NEPP site. Subject matter can include:

- PARTS
- PACKAGING
- QUALITY ASSURANCE ISSUES
- RELIABILITY ISSUES
- CURRENT EVENTS
- SPACE FLIGHT HARDWARE
- NEW TECHNOLOGY

If you wish to submit an article, please send it in electronic form to Nancy Ford at nford@qssmeds.com. Illustrations or pictures that accompany your article can also be sent electronically. If you are in the initial

stages of research please submit that also; we want to let your colleagues know what you are working on. The deadline for the "October 2000 " issue of the NEPP News Flash is September 28, 2001. If you want to talk about possible submissions feel free to give me a call 301-867-0154 and share your ideas!

Thank you and I look forward to hearing from you! Nancy Ford (301) 867-0154 QSS Group Inc., Editor, EEE Links and News Flash E-mail address: nford@qssmeds.com.

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Articles Are Being Accepted For The "November 2001" Issue Of

EEE LINKS

(Deadline for Articles October 16, 2001)

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We want to hear from you! The EEE Links Newsletter is a great way to share practical experiences and discoveries with your colleagues. Articles can be informal and from **one paragraph to three pages in length** on the following subjects:

- PARTS
- PACKAGING
- QUALITY ASSURANCE ISSUES
- RELIABILITY ISSUES
- CURRENT EVENTS
- SPACE FLIGHT HARDWARE
- NEW TECHNOLOGY

If you wish to submit an article, please send it in electronic form to Nancy Ford at nford@qssmeds.com. Illustrations or pictures that accompany your article can also be sent electronically. If you are in the initial stages of research please submit that also; we want to let your colleagues know what you are working on. The deadline for the "November 2001" issue of EEE Links is October 16, 2001. If you want to talk about possible submissions, feel free to give me a call 301-867-0154 and share your ideas!

Thank you and I look forward to hearing from you! Nancy Ford (301) 867-0154 QSS Group Inc., Editor, EEE Links and News Flash E-mail address: nford@qssmeds.com.

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CONTACT US!

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Working on new technologies? Have an idea or suggestion? We want to hear from you! If you would like to submit an article for publication in an upcoming edition of the NEPP News Flash, please contact us.

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